GRADE STABILIZATION STRUCTURE

(No.)
Code 410

Natural Resources Conservation Service
Conservation Practice Standard

I. Definition

A structure used to control the grade and head cutting in natural or artificial channels.

II. Purposes

To stabilize the grade and control erosion in natural or artificial channels, to prevent the formation or advance of gullies, and to enhance environmental quality and reduce pollution hazards.

This standard does not apply to structures designed to control the rate of flow or to regulate the water level in channels as described in Natural Resources Conservation Service (NRCS) Field Office Technical Guide (FOTG) Section IV, Standard for Structure for Water Control (587).

III. Conditions Where Practice Applies

In areas where the concentration and flow velocity of water require structures to stabilize the grade in channels or to control gully erosion. Special attention shall be given to maintaining or improving habitat for fish and wildlife where applicable.

This standard applies to all types of grade stabilization structures, including rock and sod chutes. They may be a combination of earth embankments and structural spillways and may be full-flow or detention-type structures. This standard also applies to channel side-inlet structures installed to lower the water from a field elevation, a surface drain, or a waterway to a deeper outlet channel.

This standard applies to structures where:

- Failure of the structure will not result in loss of life; in damage to homes, commercial or industrial buildings, main highways, or railroads; or in interruption of the use or service of public utilities.
- The product of the *storage*[1] times the *effective height* of the structure is less than 3,000.
- The effective height of the structure is 35 feet or less, and the structure is *low hazard potential*.

Note: Low hazard classification dams with a product of storage times the effective height of the dam of 3,000 or more; those more than 35 feet in effective height; and all *significant* and *high hazard potential* dams are to meet or exceed the requirements of NRCS Technical Release 60 (TR-60), Earth Dams and Reservoirs.

The structure owner must have ownership or legal control of the structure site and impoundment including the right to flood all land in the impoundment up to the *1% flood event*. Legal control is usually obtained through permanent easements recorded on the deed of the affected property.

The structure cannot be constructed within 400 feet of an existing or proposed public or municipal well. Additionally, it cannot be constructed within a horizontal separation distance of 25 feet of an existing or proposed private well, pond, or spring. This distance is measured from the edge of the pond formed during the 1% flood event.

IV. Federal, State, and Local Laws

Grade stabilization structures shall comply with all federal, state and local laws, rules or regulations. The owner and/or operator is responsible for securing required permits. Permitting authorities should be contacted during the planning phase of the project. This standard does not contain the text of the federal, state or local laws.

Reference to the use of this standard in any local or state regulation does not prohibit any design or method of construction by a registered professional engineer provided such alternative is approved by the enforcing agency.

[1] Words in the standard that are shown in italics are described in X. Definitions. The words are italicized the first time they are used in the text.

V. Criteria

A. General Criteria

The earth embankment and *auxiliary spillway* of structures for which criteria are not provided under NRCS FOTG Section IV, Standard for Pond (378) or in TR-60 must be stable for designed conditions. The foundation preparation, compaction, top width, and side slopes must ensure a stable dam for design flow conditions. Discharge from the structure shall be sufficient so no damage to crops or adjacent property results from flow detention.

Necessary *sediment storage* capacity must be provided for the expected life of the structure, unless a provision is made for periodic cleanout.

1. Site Assessment

   A site assessment shall be conducted, documented, and incorporated into the design. The assessment shall be performed to determine physical site characteristics that will influence the placement, construction, maintenance, and environmental integrity of the proposed structure. The assessment shall include input from the owner/operator. The site assessment shall include:

   a. Locations and elevations of buildings, roads, lanes, soil test pits, property lines, setbacks, easements, springs, wells, floodplains, surface drains, drain tile, utilities, overhead lines, cultural resources, wetlands, and potential contamination sources.

   b. Test pit logs, soil test results, and a soil survey photo, if available. Test pits or test holes shall include:

      (1) The number and distribution needed to characterize the subsurface. Key areas to be investigated include the foundation, auxiliary spillway area, and borrow area.

      (2) The elevation of *bedrock* and bedrock type, if encountered, such as sandstone, limestone, dolomite, or granite.

      (3) Saturation indicators, if encountered, such as seepage from sand and gravel lenses, lens thickness, and elevation. Ground water maps and well construction logs may be included when available and applicable.

   c. Locations and elevations of *sinkholes* and other *karst* features within 500 feet of any impoundment.

   d. Locations and elevations, soil volumes, soil samples, and reclamation plans of any borrow areas.

   e. Identification of potential impacts from failure of the embankments, liners, or structures. Document hazard potential classification.

   f. An estimate or measurement of the base flow rate, when present.

   g. Identification of navigability, water quality and wetland issues by permitting authorities.

2. Well Abandonment

   Any private well closer than a horizontal separation distance of 25 feet or any public or municipal well within 400 feet of the pond formed during the 1% flood event, shall be properly decommissioned in accordance with Wisconsin Administrative Code Chapter NR 812 and NRCS FOTG Section IV, Standard for Well Decommissioning (351).

3. Erosion and Sediment Control

   Construction operations shall be carried out in such a manner and sequence that erosion and water pollution will be minimized. Sources for acceptable construction site erosion/sediment control practices can be found in NRCS FOTG Section IV, NRCS Wisconsin Standard Detail Drawings For Conservation Practices, Department of Natural Resources (DNR) Construction Site Erosion Control Best Management Practices (BMPs), and Chapter 10 of the Department of Transportation (DOT) Facility Development Manual.

4. Safety

Grade stabilization structures are potentially hazardous and precautions must be taken to prevent serious injury or loss of life. Protective guardrails, warning signs, fences, or lifesaving equipment shall be added as needed.

If the area is used for livestock, the structure, earthfill, *vegetated spillway*, and other areas should be fenced as necessary to protect the structure. Near urban areas, fencing may be necessary to control access and exclude traffic that may damage the structure or to prevent serious injury or death to trespassers. Grates on inlet pipes may be used for safety if the drainage area will produce no significant trash or additional trash racks are installed. The capacity of the grate must be considered in the design.

5. Surface Stabilization

   The exposed surfaces of the embankment, auxiliary spillway, borrow area, and other areas disturbed during construction shall be seeded or sodded as necessary to prevent erosion. Seeding and mulching shall be according to the NRCS FOTG Section IV, Standards for Critical Area Planting (342) and Mulching (484). These vegetated areas shall be properly managed to prevent damage. Borrow areas shall be seeded as needed, according to land use practices.

6. Outlets for Subsurface Drains

   Subsurface drains should outlet in the channel downstream from structures. If a subsurface drain outlets through a structure wall, a minimum 10-foot length of nonperforated pipe shall be used. The space between the structure wall and the continuous pipe shall be sealed to prevent piping. Metal structures may have a metal pipe welded to the structure to which an outlet pipe may be connected.

B. Specific Design Criteria

The structure must be designed for stability. The crest of the inlet must be set at an elevation that stabilizes upstream head cutting. For all structures other than *full-flow open* and *side inlet drainage structures*, minimum *spillway* capacity criteria in Table 1 shall be followed.

1. Embankment Dams

   Embankment dams shall meet or exceed requirements specified in Section V.B.1. of NRCS FOTG Section IV, Standard for Pond (378). Refer to Section V.A. in Standard 378 for additional criteria.

2. Full-Flow Open Structures

   The minimum capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2.

   a. Drop, chute, box inlet drop spillways and toewall drop structures

      Drop, chute, and box inlet drop spillways shall be designed according to the principles set forth in NRCS National Engineering Handbook (NEH), Part 650 Engineering Field Handbook (EFH), Chapter 6 and other applicable NRCS publications and reports. Structures must not create unstable conditions upstream or downstream. Provisions must be made to insure reentry of bypassed storm flows into the downstream channel.

      Toewall drop structures can only be used if the vertical *overfall height* is 4 feet or less, flows are intermittent, downstream grades are stable, and tailwater depth at design flow is equal to or greater than one-third of the overfall height. Toewall drop structures shall be designed according to the principles set forth in NRCS NEH Part 650, EFH, Chapter 6.

      (1) Drainage systems

         Drainage systems shall be provided for headwalls and sidewalls of structures having an overfall height of 4 feet or more. Drainage components may consist of collection pipes, "weep" holes, or drain fill material.

(2) Riprap for drop spillways and toewall drop structures

Riprap shall be placed at least 3 feet upstream and 5 feet downstream from structures with the following dimensions.

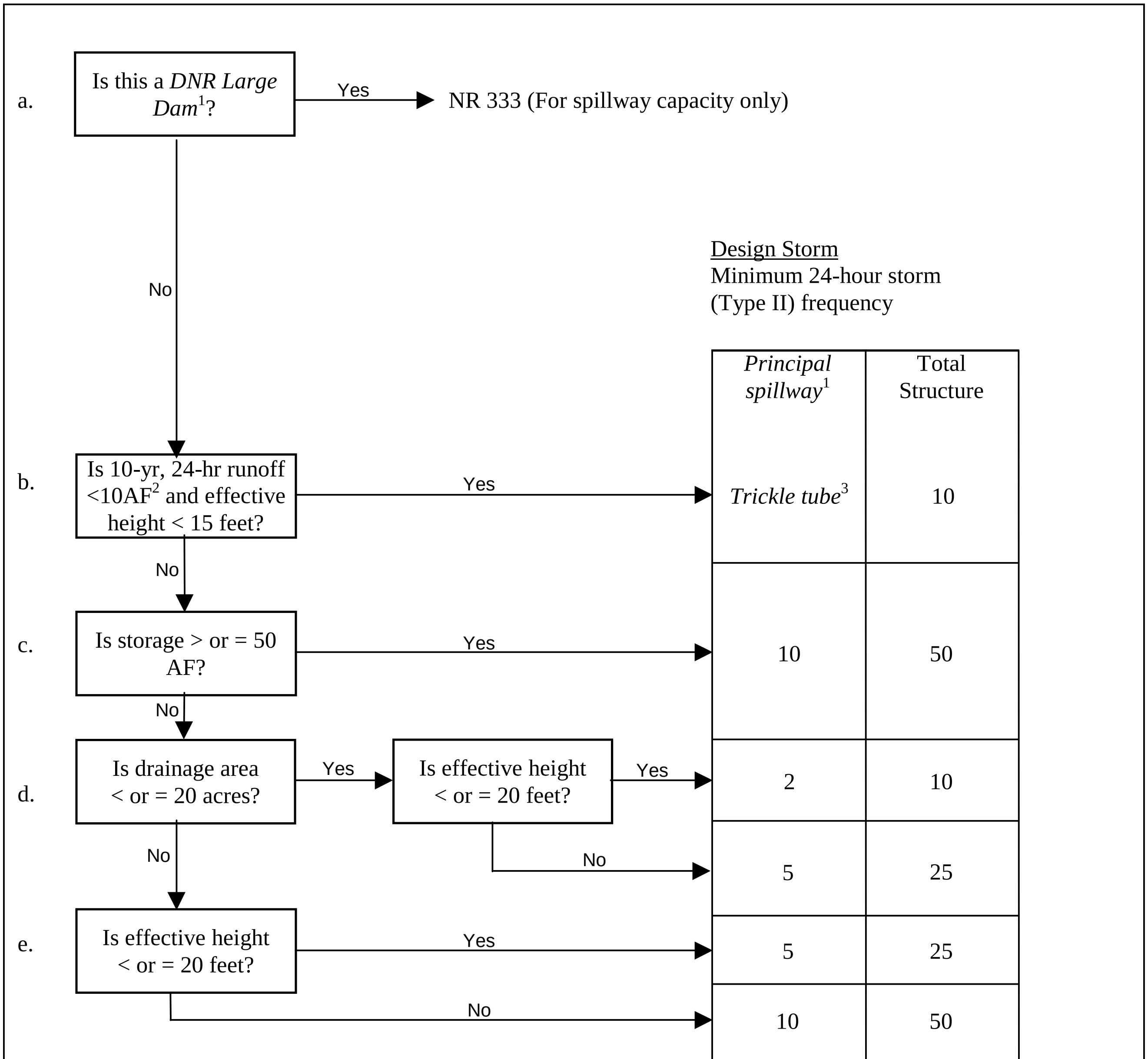
- Drop spillways or toewall drop structures with weir depths 2.5 feet or greater.
- Drop spillways with an overfall height of 4 feet or greater.
- Toewall drop structures with overfall heights of 3 feet or greater.

If tailwater depth is less than three-fourths of the overfall height, the length of riprap needs to be evaluated. For additional guidance, see NRCS NEH Section 11, Drop Spillways.

(3) Embankment for drop spillways and toewall drop structures

The embankment shall extend at least 1 foot above the headwall extension and have a top width of 6 feet or more. The combined upstream and downstream side slopes shall not be less than 5 horizontal to 1 vertical, and neither slope shall be steeper and 2 horizontal to 1 vertical.

Table 1 - Minimum Spillway Capacity



[1] Consideration should be given to increasing principal spillway design storm frequency to reduce the frequency of the auxiliary spillway's use.

[2] AF = acre-feet

[3] Trickle tube or other type of mechanical spillway required. If another type of mechanical spillway is used, it shall meet the separation distances required for a trickle tube. If a trickle tube is used, it shall be a 4-inch diameter minimum conduit, or the size required to pass 2 times the base flow. Trickle tube material shall meet the requirements of NRCS FOTG Standard 620, Underground Outlet.

Table 2 – Design Criteria for Establishing Minimum Capacity of Full-Flow Open Structures

Maximum Drainage Area (acre)	Overfall Height [1] (ft)	Minimum 24-hr design storm (Type II) frequency	
		Principal spillway capacity (yr)	Total capacity (yr) [2]
50	5 or less	2 [3]	10
250	5 or less	5	10
500	10 or less	10	25
All others		25	100

[1] For rock chutes, this is measured from the inlet apron to the design elevation of the outlet channel.
[2] If an island type structure, auxiliary spillway flow must be bypassed at a nonerosive velocity for reentry into the downstream channel.
[3] *Design drainage curve "A"* may be used. See NRCS NEH Part 650, EFH, Chapter 14.

(4) Headwall elevation for drop spillways and toewall drop structures

The minimum headwall elevation shall be set by adding 0.25 feet to the design flow depth over the weir.

b. Drop box structures

The capacity of drop boxes attached to road culverts shall be as required by the responsible road authority or as specified in Table 2. The drop box capacity (attached to a new or existing culvert) must equal or exceed the culvert capacity at design flow.

c. Gabion structures

Structures made of rock-filled gabions can be used for vertical overfall heights of 8 feet or less. When available, manufacturer's instructions shall be used in the design for this type of structure. Otherwise, use guidelines for proportioning drop spillways, shown in NRCS NEH Section 11, Standard Drawing ES-67. The following items apply to gabion design:

(1) Aprons or stilling basins shall be installed downstream from the weir to prevent undercutting.

(2) Structures must be keyed into both banks to prevent flanking during high water.

(3) Foundations must provide sufficient strength to adequately support the structure.

(4) The structural components must be tied or stacked so they will act as a unit to prevent overturning or displacement by the action of ice and water.

(5) Suitable drain fill material or geotextile shall be placed adjacent to the baskets to prevent piping of foundation soil material into the rock-filled gabions.

Table 3 – Rock Gradation

Percent Passing	Size[1] (in)
100	1.5 x D_{50}*[2] -- 2.0 x D_{50}*
85	1.3 x D_{50}* -- 1.8 x D_{50}*
50	1.0 x D_{50}* -- 1.5 x D_{50}*
10	0.8 x D_{50}* -- 1.3 x D_{50}*

[1] Round up to nearest inch.
[2] D_{50}* is the specified D_{50} which equals the designed D_{50} x factor of safety.

d. Rock chutes

The cross section of the completed chute shall be trapezoidal. Side slopes shall be 2 horizontal to 1 vertical or flatter.

Chutes shall be designed by using the D_{50} rock size for a roughness value, allowable velocity, rock gradation and thickness of the rock layer. A minimum factor of safety (FS) of 1.2 shall be used to size the rock. The rock gradation shall be as shown in Table 3. NRCS NEH Part 650, EFH Chapter 6; American Society of Agricultural Engineers (ASAE) Paper No. 972062, "Design of Rock Chutes"; ASAE Paper No. 982136 "Rock Chutes on Slopes Between 2% and 40%"; or ASAE Paper No. 002008, "An EXCEL Program to Design Rock Chutes for Grade Stabilization" shall be used for the design.

The following criteria apply to all rock chutes:

(1) The rock-lined section must be straight.

(2) The maximum chute slope shall be 3 horizontal to 1 vertical.

(3) The minimum depth for the chute shall be the design flow depth needed to pass the design flow through a trapezoidal-shaped, broad-crested weir at the inlet or the depth of the hydraulic jump at the outlet, plus 0.5 feet.

(4) Inlet apron

The length shall be a minimum of 10 feet and be flat (0% grade).

(5) Outlet apron

i. The outlet apron shall be flat (0 % grade).

ii. The length of the outlet apron shall be 15 x D_{50} (ft) x FS and recessed a minimum of 1 foot below the outlet channel bottom.

(6) The minimum rock thickness shall be 2 times the D_{50}* rock size.

(7) A geotextile must be placed beneath the rock. If a sand-gravel bedding is used, the bedding thickness shall be a minimum of 2 inches and placed beneath the geotextile.

(8) Flow in the upstream channel shall be sub-critical. The upstream channel shall be at least as wide as the chute inlet apron for a

minimum of 50 feet upstream of the chute inlet apron.

(9) The bottom width and side slopes of downstream channels in line with the chute shall be the same as the bottom width and side slopes at the downstream end of the outlet apron. A transition section in the downstream channel at least 50 feet long must be provided for other channel dimensions or configurations.

The slope of the downstream channel shall be stable at the design flow for a minimum distance of 100 feet and provide sufficient tailwater on the rock chute.

(10) Outlets other than in-line channels shall be stable and provide sufficient tailwater at the design flow.

e. Sod chutes

Sod chutes shall be designed according to the procedures shown in NRCS NEH Part 650, EFH Chapters 6 and 7. The maximum design velocity shall not exceed 6 feet/second. Sod strips shall extend a minimum of 2 feet on the side slope (measured on the sloping plane) or provide 0.3 feet *freeboard* above the flow depth, whichever is greater.

Sod chutes which outlet into permanent tailwater or other conditions which will not support continuous vegetation shall be protected from erosion by drop structures, rock riprap or other suitable methods.

Turf reinforcement can be used to increase the maximum design velocity. Maximum velocity shall be based on manufacturer’s recommendations but not to exceed 10 feet/second for erosion-resistant soils and 8 feet/second for easily eroded soils as defined in NRCS NEH Part 650, EFH Chapter 7. Installation of the turf reinforcement shall be based on manufacturer’s recommendations.

3. Island-Type Structures

For *island-type structures*, the minimum capacity shall equal the capacity of the downstream channel. For channels with very small drainage areas, the spillway should carry at least the 2-year frequency, 24-hour duration storm or the design drainage curve runoff. The minimum auxiliary spillway capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2 for total capacity without overtopping the headwall extensions of the structure. Provisions must be made for safe reentry of bypassed flow into the downstream channel.

4. Side-Inlet Drainage Structures

The design criteria for the minimum capacity of open-weir or pipe structures used to lower surface water from field elevations or lateral channels into deeper open channels are shown in Table 4.

When the average watershed slope is 1% or flatter, structures used as side inlets along channels shall have a capacity equal to or greater than the flow of the side channel flowing full. The area immediately upstream from the structure shall be flat so out-of-bank flow will spread over a large area. Embankments shall be constructed high enough to prevent water from overtopping the fill near the structure location.

VI. Operations and Maintenance

An operation and maintenance plan shall be prepared for use by the owners or others responsible for operating and maintaining the system. The plan shall provide specific instructions for operating and maintaining the system to ensure that it functions properly. It shall also provide for periodic inspections and prompt repair or replacement of damaged components.

Table 4 – Design Criteria for Establishing Minimum Capacity of Side-Inlet Drainage Structures

Maximum Drainage Area (acre)	Overfall Height (ft)	Receiving Channel Depth (ft)	Minimum 24-hr design storm (Type II) frequency	
			Principal Spillway Capacity	Total Capacity (yr)
250	0-5	0-10	Design Drainage Curve “A” Runoff [1]	5
250	5-10	10-20	Design Drainage Curve “A” Runoff [1]	10
500	0-10	0-20	Design Drainage Curve “A” Runoff [1]	25
All others			Design Drainage Curve “A” Runoff [1]	50

[1] See NRCS NEH Part 650, EFH, Chapter 14.

VII. Considerations

Additional recommendations relating to design which may enhance the use of, or avoid problems with, this practice, but are not required to ensure its basic conservation function are as follows:

A. Water Quantity

Consider:

- Effects on volumes and rates of runoff, evaporation, deep percolation, and ground water recharge.
- Effects of the structure on soil water and resulting changes in plant growth and transpiration.

B. Water Quality

Consider:

- Ability of structure to trap sediment and sediment-attached substances carried by runoff.
- Effect of structure on the susceptibility of downstream stream banks and streambeds to erosion.
- Effects of the proposed structure on the movement of dissolved substances to ground water.
- Effects on the visual quality of downstream water resources.

C. Approach channel for spillways

The approach channel should be straight for a minimum of 100 feet upstream from the structure.

D. The visual resource can be enhanced by:

- Shaping and blending excavated material and cut slopes into the natural topography
- Shaping shorelines and creating islands to add visual interest and valuable wildlife habitat
- Forming, finishing, and adding texture to exposed concrete surfaces to reduce reflection and to alter color contrast
- Selecting plant materials which will visually and functionally complement their surroundings

E. Top width for a dam should be wide enough to accommodate farm machinery and other vehicles.

F. If mowing is specified as part of the maintenance plan, the side slope of the dam should be 3:1 or flatter.

G. When rodent damage is expected, include appropriate embankment protection measures.

H. Typical minimum core trench depth is 3 feet.

I. Other

- Consider conservation and stabilization of archaeological and historic sites when designing this practice. This practice has the potential of positively and/or negatively affecting cultural resources. Follow applicable federal or state policy for considering cultural resources during planning and maintenance.
- The effect a structure will have on the aquatic habitat of a channel. If the channel supports fish, the effect of a structure on the passage of fish should be considered.
- Structures installed in natural channels should be compatible with the fluvial geomorphic conditions at the site to ensure the stability of the structure.

VIII. Design Documentation, Plans and Specifications

Plans and specifications for installing grade stabilization structures shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

Specifications for grade stabilization structures within the scope of the NRCS FOTG Section IV, Standard for Pond (378) shall, as a minimum, be commensurate with those for ponds. Grade stabilization structures within the scope of TR-60 shall be constructed according to the guide specifications in the National Engineering Handbook, Section 20.

A. Design Documentation Requirements

Location map, hydrology and hydraulic computations, water storage volumes, load requirements for headwalls (if standard plans provide maximum loading conditions), profile of any constructed channels extending several hundred feet upstream and downstream from structure, profile along centerline of structure, foundation investigation data; elevations of inlets, weirs, outlets, etc.; materials, riprap dimensions, vegetative requirements.

B. Plans and Specifications

Location map, soil boring logs, profile along centerline of structure, profile of any constructed channels extending several hundred feet upstream and downstream from structure, cross section along principal spillway (or maximum cross section if no principal spillway), profile of auxiliary spillway, side slopes, elevations of inlets, weirs, and outlets, seeding requirements, erosion and sediment control plan, site plan with existing contours and structure layout, applicable elevations, dimensions, materials, vegetative requirements, applicable specifications, and other applicable data, sections, and details.

C. As-Built Documentation

Dimensions of inlets, weirs, outlets, etc.; materials used, rock gradation, quality tests and thickness, filter material type (gradation and thickness, if applicable), profile and cross section of embankment; size, thickness, and source of pipe spillway materials; statement regarding adequacy of vegetation.

IX. References

American Society of Agricultural Engineers (ASAE), Paper no. 972062, “Design of Rock Chutes.”

American Society of Agricultural Engineers (ASAE), Paper no. 982136, “Rock Chutes on Slopes Between 2% and 40%.”

USDA NRCS documents may be obtained by contacting:

- National Technical Information Service
  U.S. Department of Commerce
  5385 Port Royal Road
  Springfield, VA 22151
  (703) 487-4650

- Superintendent of Documents
  U.S. Government Printing Office
  Washington, D.C. 20401

- National NRCS Home Page
  www.nrcs.usda.gov

- Wisconsin NRCS Home Page
  www.wi.nrcs.usda.gov

United States Department of Agriculture – Natural Resources Conservation Service, National Engineering Handbook Part 650, Engineering Field Handbook.

United States Department of Agriculture – Natural Resources Conservation Service, National Engineering Handbook Part 633 Soil Engineering, Chapter 26 Gradation Design of Sand and Gravel Filters.

United States Department of Agriculture – Natural Resources Conservation Service, Wisconsin Field Office Technical Guide, Section IV (Conservation Practice Standards and Wisconsin Specifications).

United States Department of Agriculture – Natural Resources Conservation Service, Technical Release 60, Earth Dams and Reservoirs (TR-60).

X. Definitions

1% flood event (III.) – A flood determined to be representative of large floods, which in any given year has a 1% chance of occurring or being exceeded. The 1% flood is based on a statistical analysis of lake level or streamflow records available for the watershed or an analysis of rainfall and runoff characteristics in the watershed, or both. This is commonly referred to as the 100 year event or regional flood.

Auxiliary spillway (V.A.) – The auxiliary spillway is the spillway designed to convey excess water through, over, or around a dam. This has been commonly referred to as an "emergency spillway".

Bedrock (V.A.1.b (2)) – Consolidated rock material and weathered in-place material with > 50%, by volume, larger than 2 mm in size.

D_{50} (V.B.2.d.) – The D_{50} rock size is the rock diameter of which 50 % of the material by weight is smaller.

*D_{50}** (V.B.2.d.(6)) – D_{50}* is the specified D_{50} which equals the designed D_{50} x factor of safety.

Design drainage curve "A" runoff (Table 2 footnote) – Curves for determining runoff for drainage design have been prepared in most of the humid areas of the United States. They are based on the climate, soils, topography and agriculture of the particular area. See NRCS EFH, Chapter 14.

DNR Large Dam (Table 1) – Any dam with a *structural height* of more than 6 feet and impounds 50 acre-feet or more of water at the design elevation or has a structural height of 25 feet or more and impounds more than 15 acre-feet of water at the design elevation. Structures meeting this definition must be designed in accordance with the standards of Wisconsin Administrative Code NR 333.

Effective height (III.) – The effective height of the dam is the difference in elevation, in feet, between the auxiliary spillway crest and the lowest point in the cross section along the centerline of the dam prior to stripping. If there is no auxiliary spillway, the design elevation for the top of the dam is the upper limit.

Freeboard (V.B.2.e.) – Freeboard is the additional depth or elevation required above computed design requirements.

Full-flow open structures (V.B.) – Full-flow open structures are those which must pass the design storm through the principal and auxiliary spillways without creating storage above the design flow's normal depth.

High hazard potential (III.) – Dams assigned the high hazard potential classification are those where failure or mis-operation will probably cause loss of human life.

Island-type structure (V.B.3.) – The island-type structure uses a drop spillway in the channel with auxiliary earth spillways for carrying excess flows around the structure. To prevent washing around the structure, dikes extending each way from the structure must be provided.

Karst (V.A.1.c.) – Refers to areas of land underlain by carbonate bedrock (limestone or dolomite). Typical land features in karst areas include sinkholes, disappearing streams, closed depressions, blind valleys, caves, and springs.

Low hazard potential (III.) – Dams assigned the low hazard potential classification are those where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are primarily limited to the owner's property.

Overfall height (V.B.2.a.) – Vertical drop from the weir crest to the downstream outlet invert.

Principal spillway (Table 1) – The principal spillway is the lowest ungated spillway designed to convey water from the reservoir (pond) at predetermined release rates.

Sediment storage (V.A.) – Sediment storage is the reservoir capacity allocated to total sediment accumulation (submerged and aerated) during the life of the dam.

Side-inlet drainage structures (V.B.) – A structure designed to convey surface water from fields or open areas into drainage ditches.

Significant hazard potential (III.) – Dams assigned the significant hazard potential classification are those dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

Sinkholes (V.A.1.c.) – Closed, usually circular, depressions that form in karst areas. Sinkholes are formed by the downward migration of unconsolidated deposits into solutionally enlarged openings in the top of bedrock.

Spillway (V.B.) – A spillway is an open or closed channel, conduit, or drop structure used to convey water from a reservoir. It may contain gates, either manually or automatically controlled, to regulate the discharge of water.

Storage (III.) – Storage is the volume, in acre-feet, in the pond below the elevation of the crest of the auxiliary spillway or below the design elevation of the top of the dam if there is no auxiliary spillway.

Structural height (*DNR Large Dam*) – The difference in the elevation between the design elevation and the lowest elevation of the natural stream or lake bed at the downstream toe of the embankment.

Trickle tube (Table 1)– A trickle tube is a minimum 4 inch diameter conduit intended to draw down the pool to a level below the auxiliary spillway. The trickle tube discharge is not credited in the design.

Vegetated spillway (V.A.4.) - A vegetated spillway is a vegetated open channel spillway in earth materials.